

WBS 1.3

IST Overview

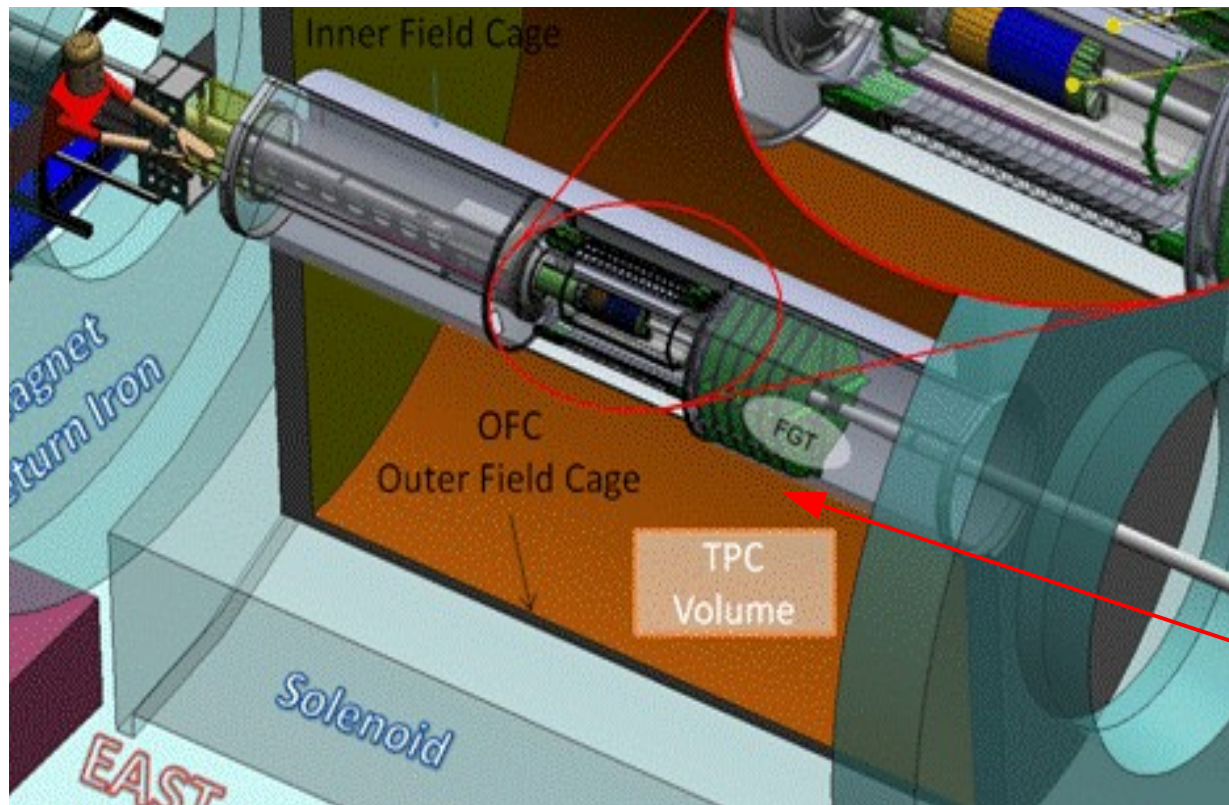
Gerrit van Nieuwenhuizen
MIT

IST presentation overview



- Detector overview
- CD-4 requirements and deliverables
- Technical description and design status
- Fabrication and testing
- Subsystem cost
- Human resources
- Milestones and risk assessment

IST in Inner Detector Upgrade



TPC – Time Projection Chamber
(main tracking detector in STAR)

HFT – Heavy Flavor Tracker

- SSD – Silicon Strip Detector
 - $r = 22 \text{ cm}$

- **IST – Inner Silicon Tracker**
 - $r = 14 \text{ cm}$

- PXL – Pixel Detector
 - $r = 2.5, 8 \text{ cm}$

FGT – Forward GEM Tracker
Shares almost identical
readout system with IST
Installation in CY2011

We track inward from the TPC with graded resolution:



IST overview



Time for a new picture

Radius	14cm
Length	50cm
ϕ -Coverage	2π
$ \eta $ -Coverage	≤ 1.2
Number of ladders	24
Number of hybrids	24
Number of sensors	144
Number of readout chips	864
Number of channels	110592
R- ϕ resolution	$172\mu\text{m}$
Z resolution	$1811\mu\text{m}$
Z pad size	$6000\mu\text{m}$
R- ϕ pad size	$600\mu\text{m}$

IST has entered production phase

IST CD-4 deliverables



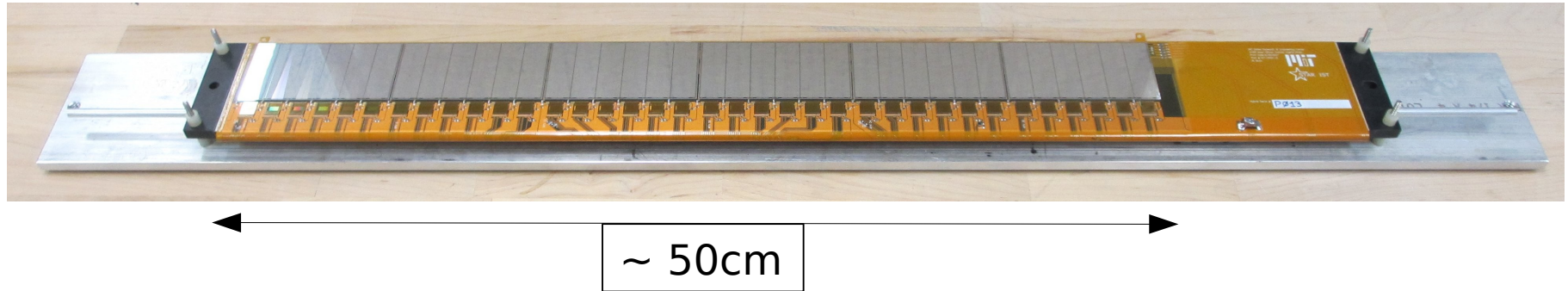
- 27 (24+3 spares) staves with six sensors per staffe
- 24 IST staves installed on the Middle Support Cylinder
- Silicon bias voltage system for 24 staves
- Readout system for 24 staves
- Cabling and Cooling Services

Delivered by March-April 2013

IST stave



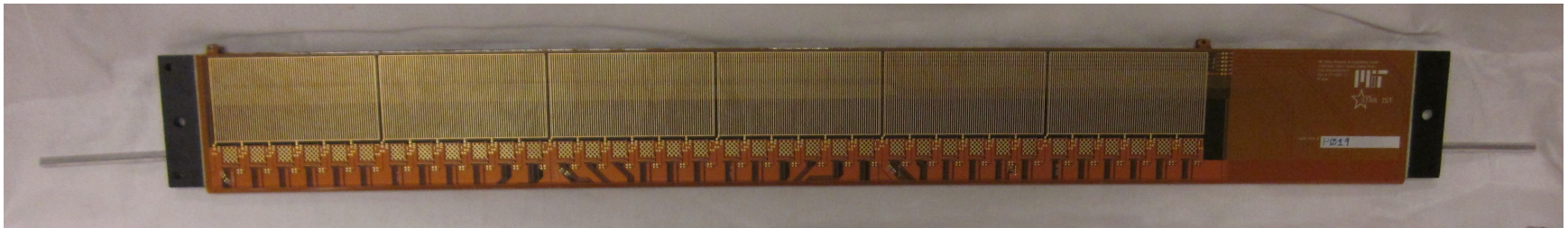
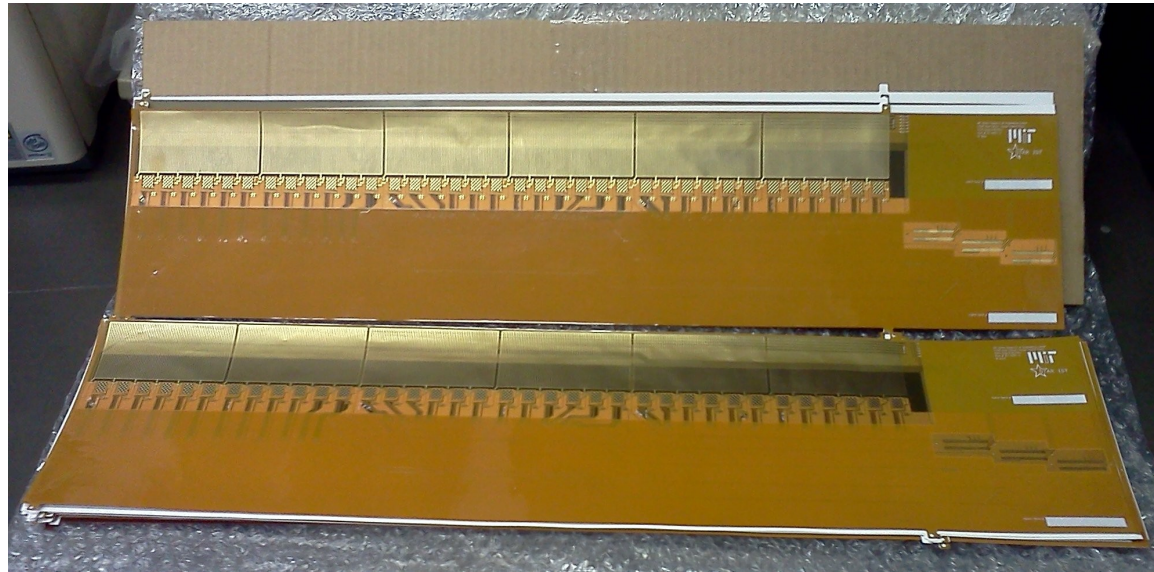
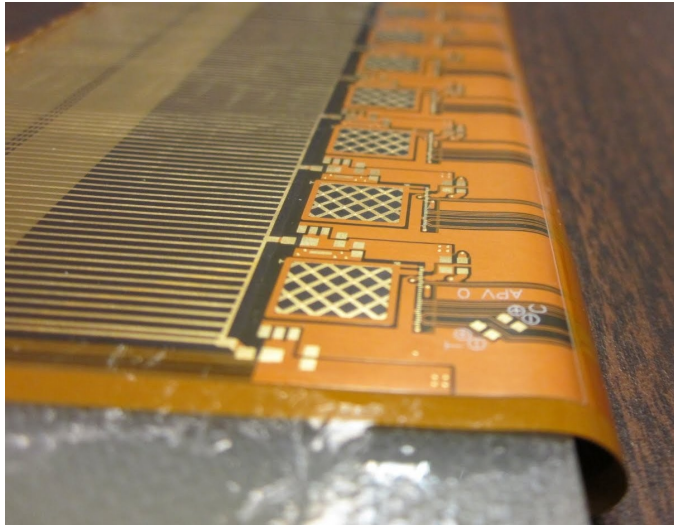
IST prototype stave



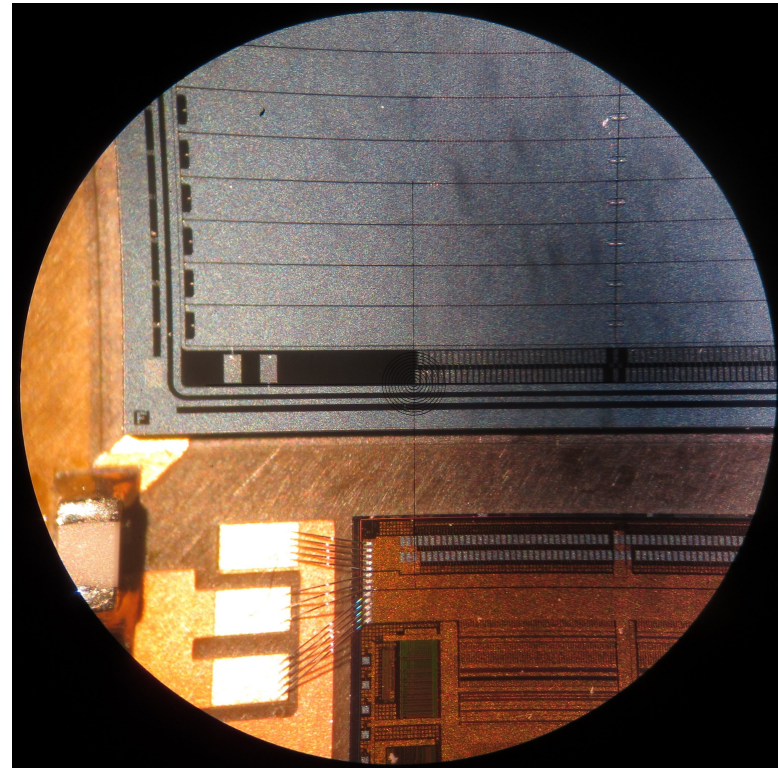
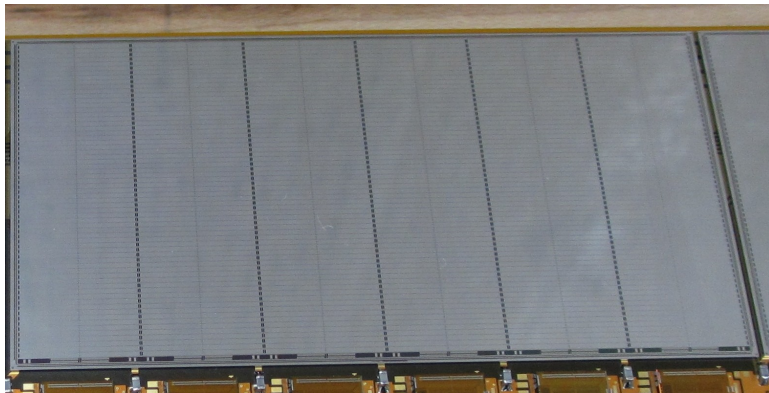
IST stave = carbon fiber ladder + cooling tubes
kapton flex hybrid + passive components
6 silicon pad sensors
3 x 12 APV25-S1 readout chips
Electrically divided in 3 units to reduce chance of failure of a full stave

Full prototype stave assembled and tested

IST ladder and hybrid



All hybrids produced and at LBNL for lamination with carbon fiber staves, ready end of August

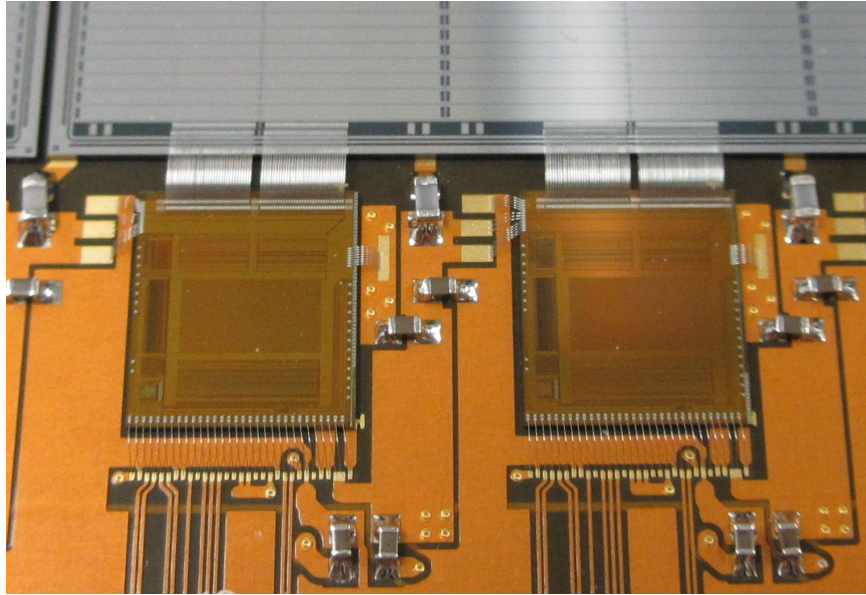


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IST readout chip



APV25-S1

**Developed for CMS
(75,000 used in tracker)
(used in COMPASS for triple GEM)**

**0.25 μ m CMOS
Radiation hard**

**128 channels parallel sampling
40 MHz sampling rate
4 μ s analogue pipeline
< 30 μ s deadtime for 20 MHz 3-samp
readout**

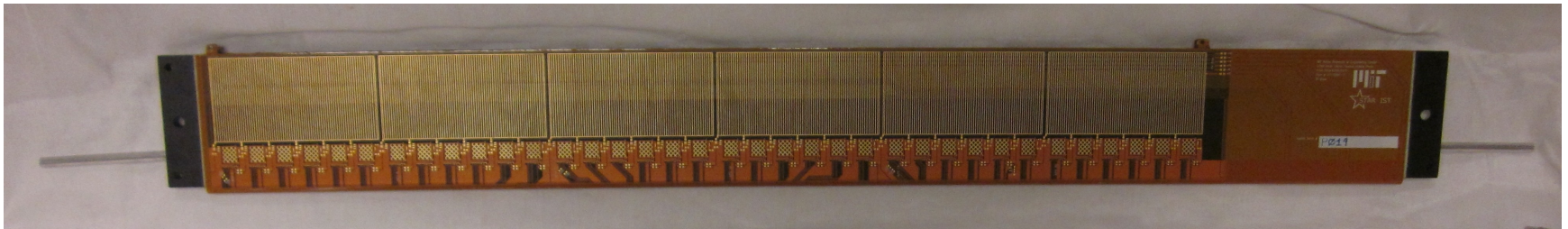
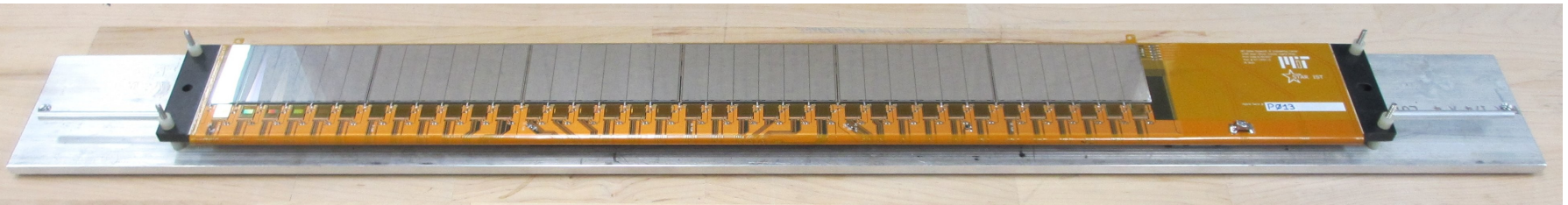
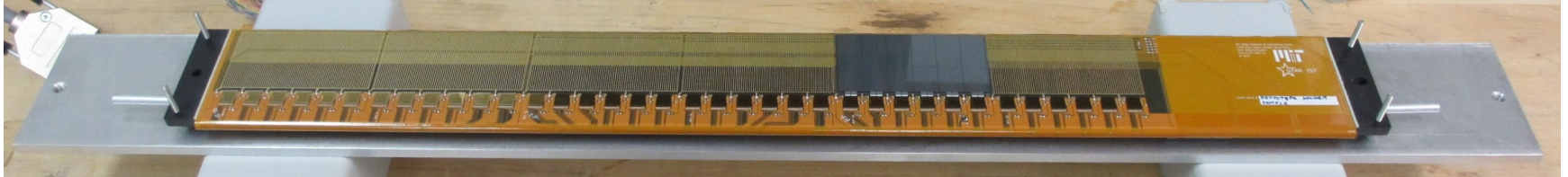
Better than 15:1 signal to noise ratio

**STAR use: - IST
- FGT**

0.3 Watt per chip

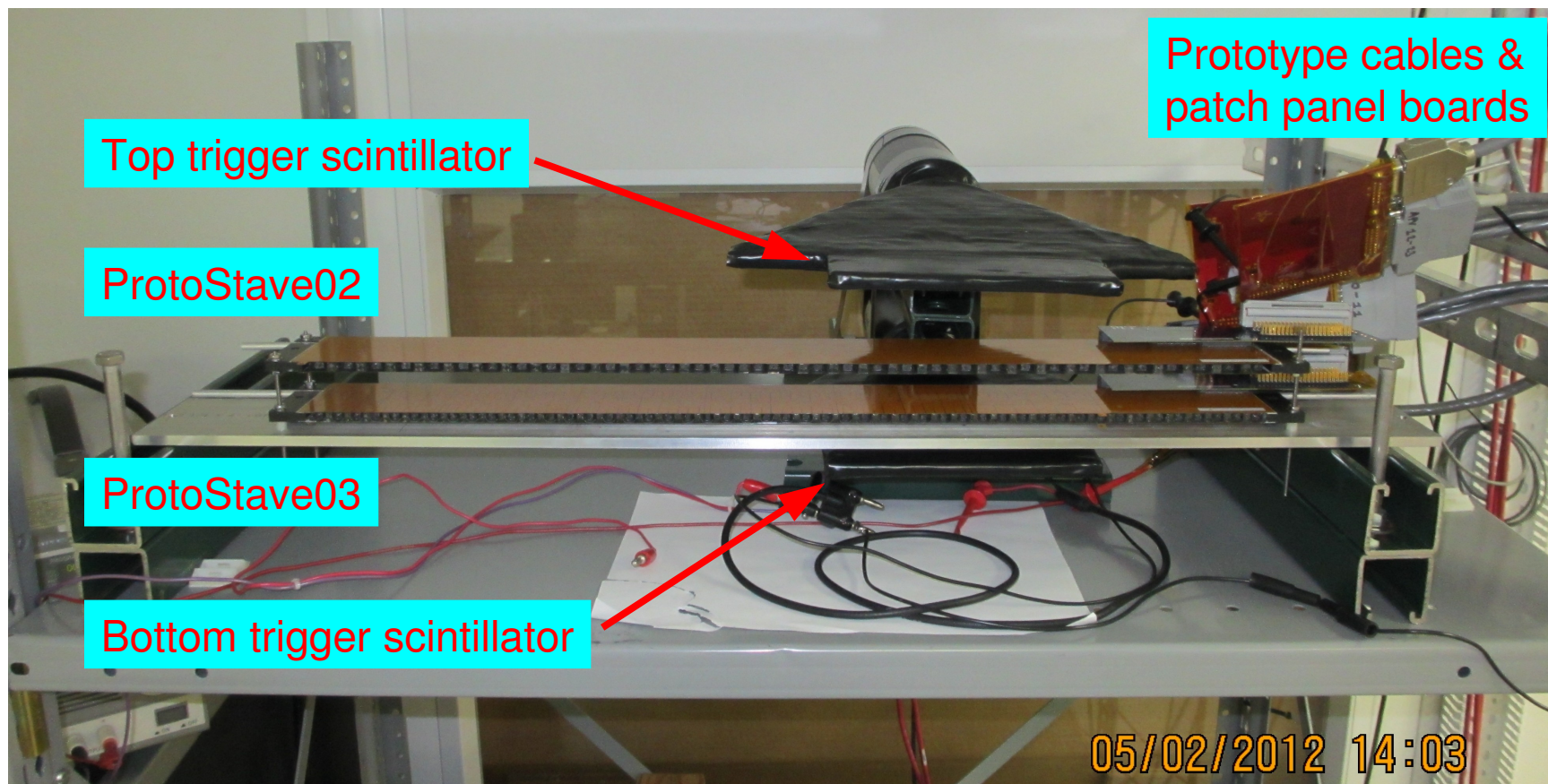
All chips ready for mounting

IST prototype staves



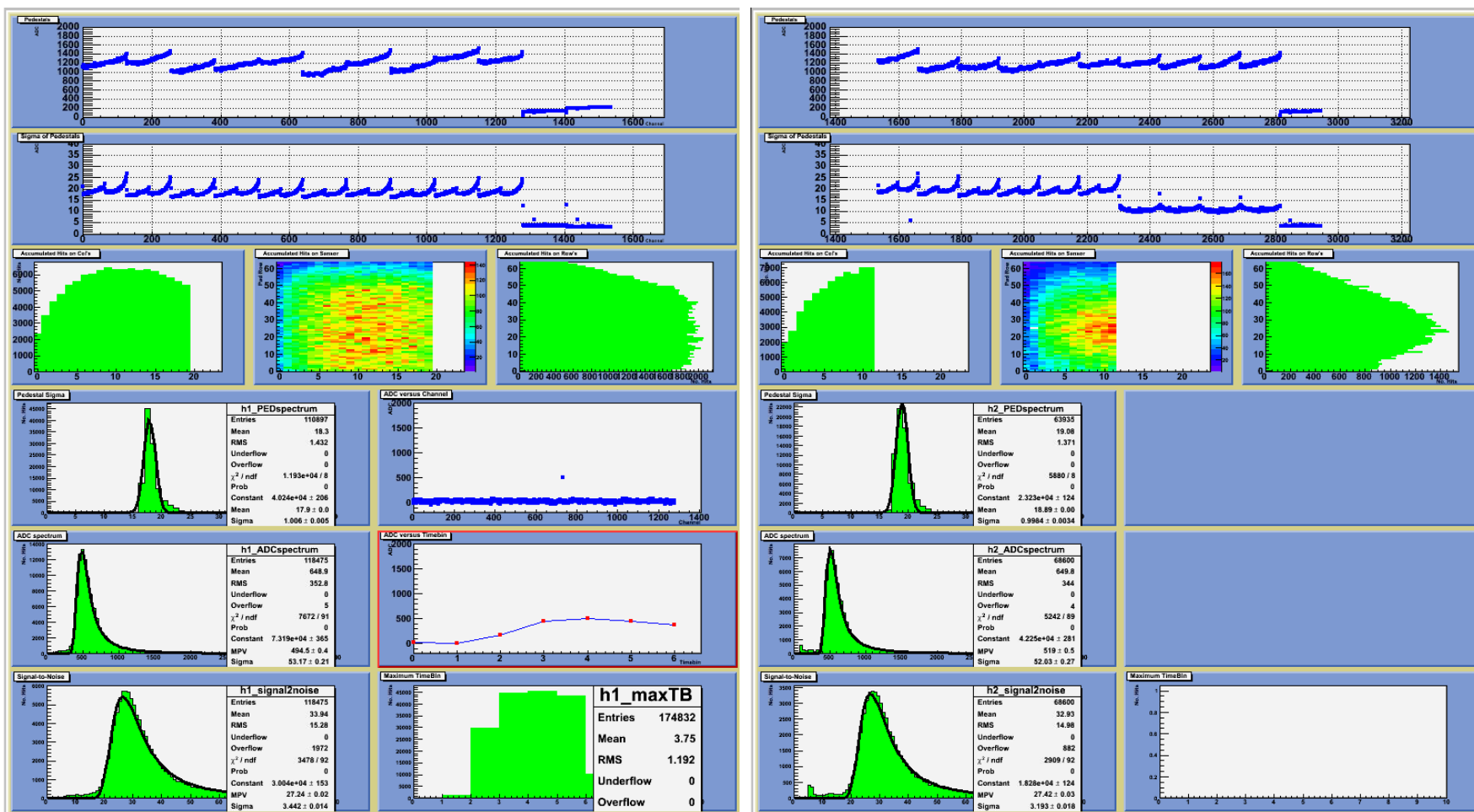
ProtoStave02, 36 APV's, 1 bonded sensor
ProtoStave03, 36 APV's, 6 bonded sensors
ProtoStave04, 12 APV's, 1 bonded sensor

IST Cosmic Ray Setup



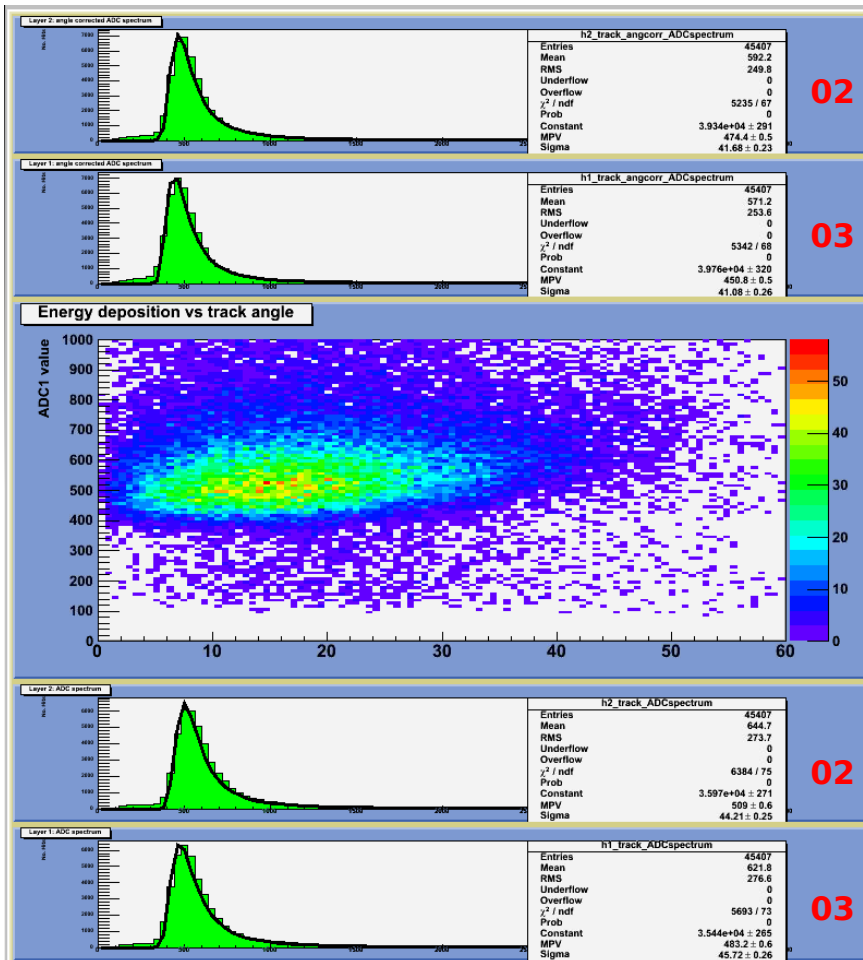
Works great at about 0.5Hz

IST Cosmic Ray Data I



Everything works as expected, > 99% functional

IST Cosmic Ray Data II



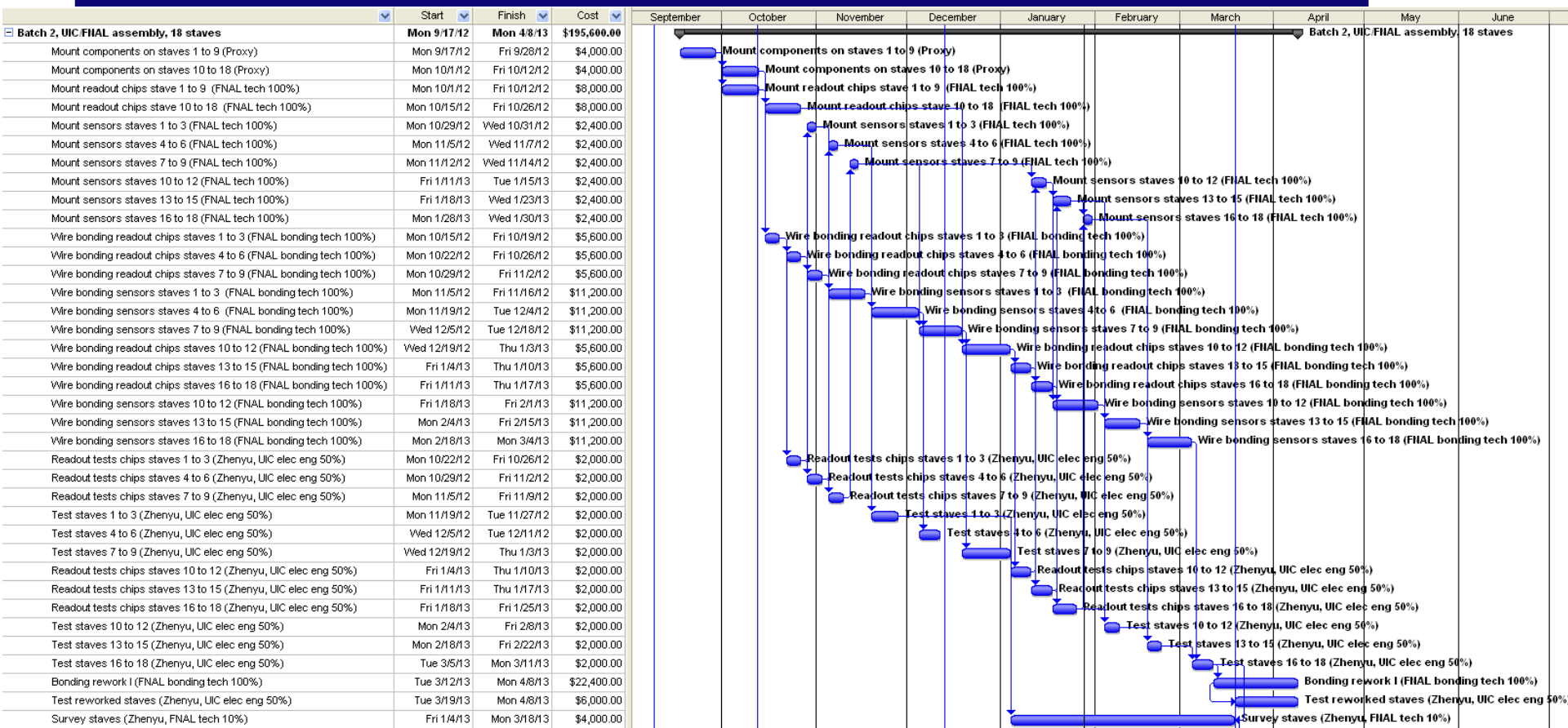
After angle correction

Signal vs Angle

Before angle correction

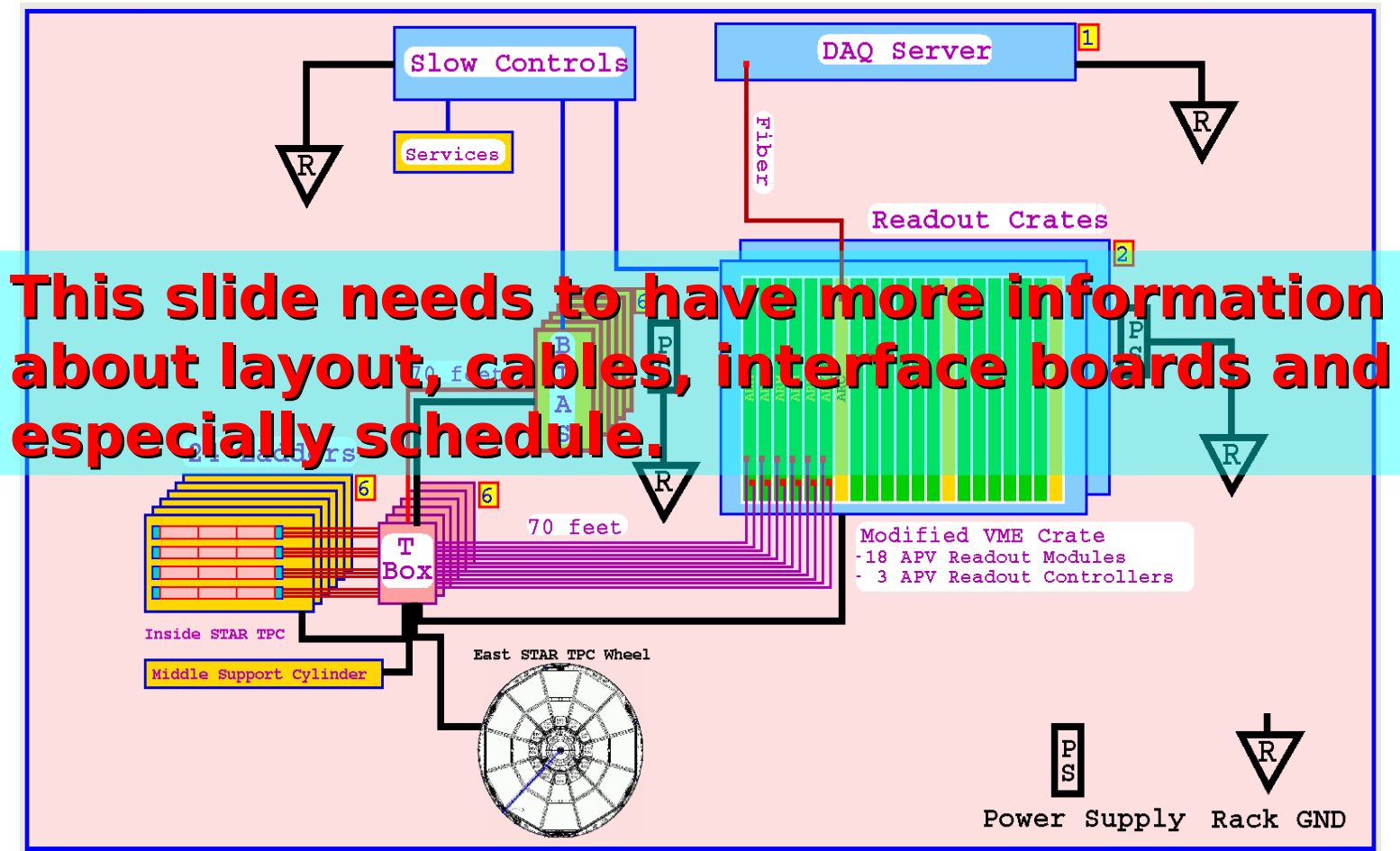
Angle correction works as expected, S/N > 20:1

IST stave production



Production at MIT/BNL & UIC/FNAL, ready Mar/Apr

IST readout system



Design 80% done, almost identical to FGT design

IST readout crate

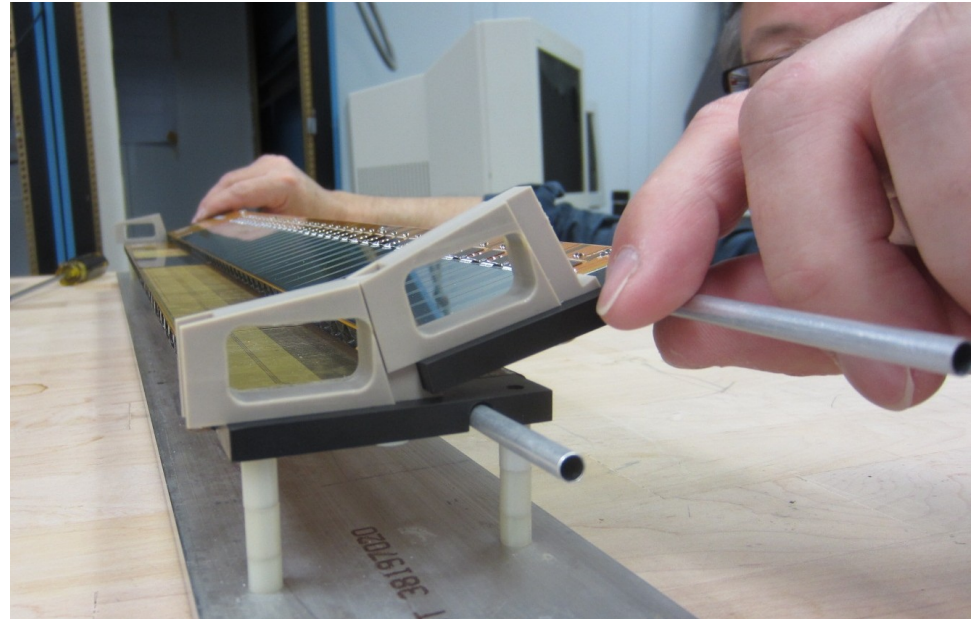
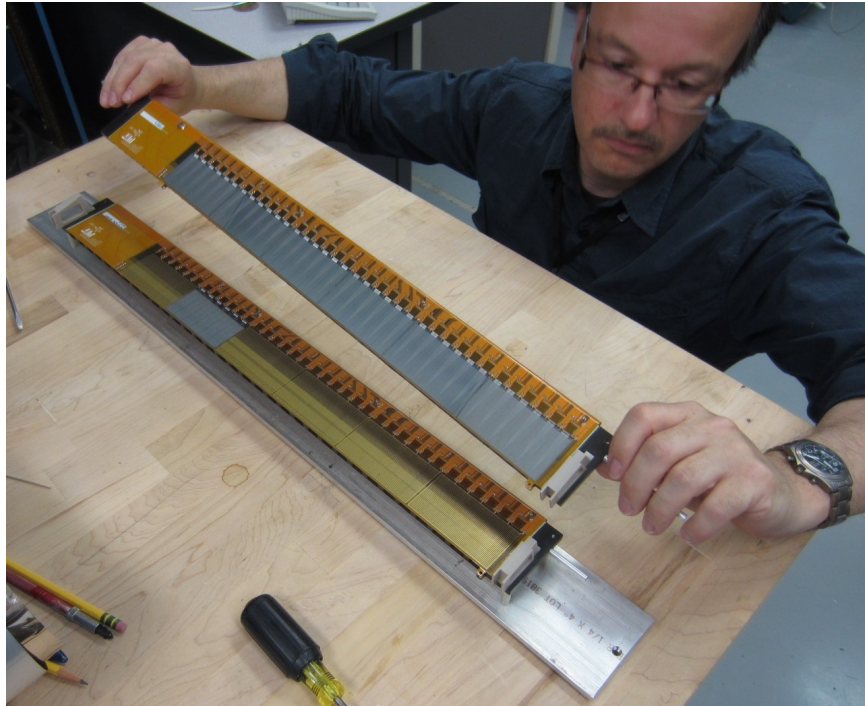
This slide needs to have more information about ARM and ARC production schedule.



Worked satisfactory for FGT in RHIC Run 12

Crate, ARM and ARC design 90% done

IST stave supports



Individual PEEK pieces support the staves

IST milestones



Level	Milestone	Planned	Actual/ Forecast
1	CD-0 Approve Mission Need		2/18/09 (A)
1	CD-1 Approve Alternative Selection and Cost Range		8/31/10 (A)
1	CD-2 Approve Performance Baseline	Q4FY11	Aug-11
1	CD-3 Approve Start of Fabrication	Q4FY11	Aug-11
1	CD-4 Approve Project Completion	Q3FY15	Jun-15
1.3	IST		
◆ 2	Sensor design Finished	Q1FY12	Jul-11
◆ 2	Prototype ladder tested	Q2FY12	Dec-11
◆ 2	Flex hybrid produced	Q3FY12	Feb-12
2	First staves produced	Q4FY12	Jun-12
2	Staves finalized	Q2FY13	Nov-12
2	IST assembled onto MSC	Q4FY13	Mar-13

First three L2 milestones met
Will miss next milestone, but mitigation in place
through doubling of production capability

IST cost by Level 3 WBS



WBS	Task Name	Cost (\$K)
1.3	Intermediate Silicon Tracker (IST)	2,480
1.3.1	Mechanics	599
1.3.2	Electronics	1,122
1.3.3	Assembly, testing and installation	759

Waiting for official Sarah stuff.....

IST human resources



Name	Function	Affiliation	Expertise
Bernd Surrow	Physicist	MIT	Sub system manager
Gerrit van Nieuwenhuizen	Physicist	MIT	Detector development
Ben Buck	Electronics Engineer	MIT-Bates	Front End Electronics, Readout
Gerard Visser	Electronics Engineer	UICF	Readout, DAQ
Jim Kelsey	Mechanical Engineer	MIT-Bates	Support Structure, Cooling
Jason Bessuille	Mechanical Engineer	MIT-Bates	Support Structure, Cooling
Eric Anderssen	Mechanical Engineer	LBNL	Support Structure
Dale Ross	Technician	MIT-LNS	Assembly
TBD	Technician	MIT	Assembly *2
TBD	Technician	MIT/BNL	Wire Bonding
Don Pinelli	Technician	BNL	Wire Bonding

+ UIC crowd and FNAL technicians + Bob Soja

IST risk assessment



Part of the full IST risk table

WBS	Risk description	Mitigation Strategy	Level
1.3.1.3.5	Ladder production delay	scheduling slack	moderate impact low severity
1.3.2.2.3	Prototype sensors specification failure	scheduling slack, reliable vendor	RETIRED moderate impact moderate severity
1.3.2.2.4	Flex hybrid prototype specification failure	scheduling slack, less prototypes	RETIRED moderate impact moderate severity
1.3.2.3.1	Sensor production problems	reliable vendor, stage batch production	moderate impact low severity
1.3.2.3.3	Flex hybrid production problems	scheduling slack by producing early	RETIRED moderate impact low severity
1.3.2.3.6	Readout system problems	Problems straightened out by FGT	RETIRED moderate impact low severity
1.3.3.3	Stave assembly problems	Establish conservative assembly pipeline	RETIRED moderate impact moderate severity
1.3.3.4	Layer integration problems	Scheduling slack, delay installation	moderate impact low severity

All risks low to moderate, mitigation strategies in place

Summary

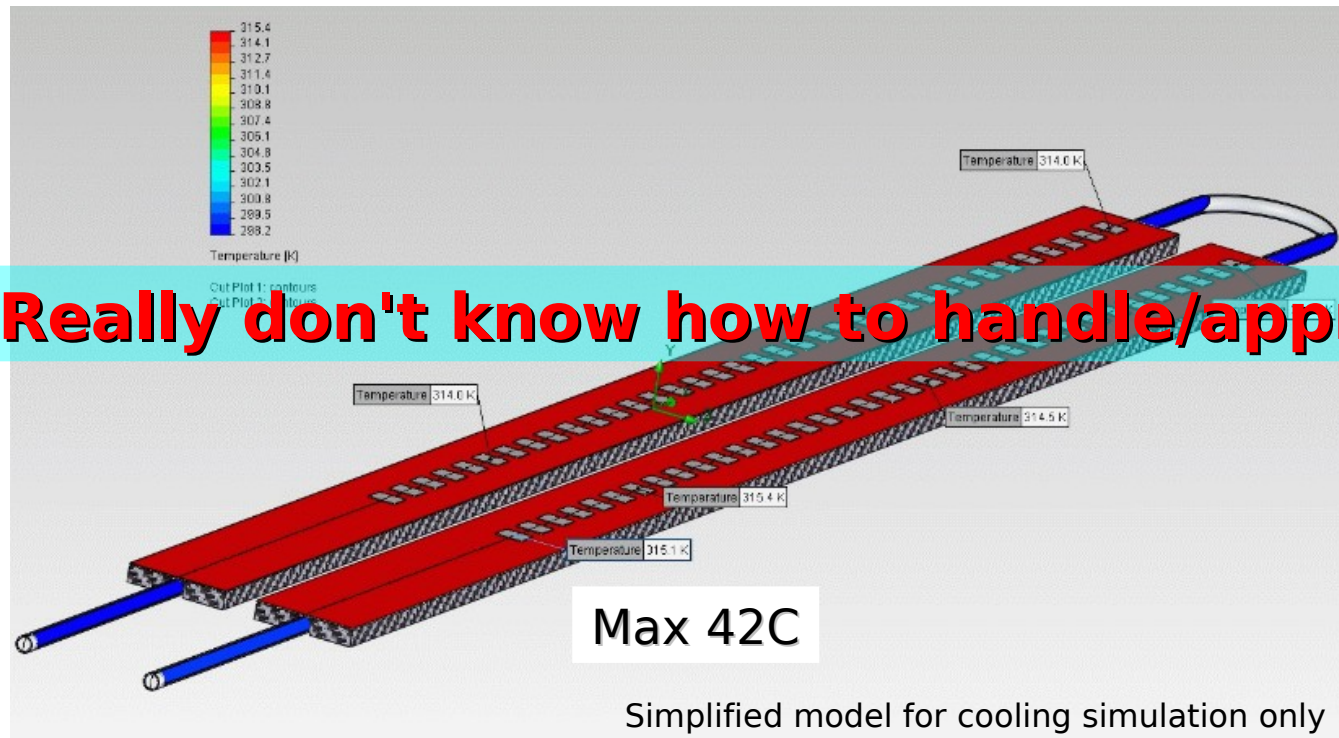


- Designs for staves 100% complete
- Designs for readout system 90% complete
- Stave prototypes functioned as expected
- Fabrication plan modified to mitigate schedule delays
- Resources are sufficient to satisfy the schedule
- The risk severity is low to moderate for all major subsystem tasks, mitigation strategies are in place or activated already and many risks have been retired

Backup slides



IST cooling



3M Novec 7200
fluorocarbon cooling
fluid

Inlet 24C
(TPC oper.T)

550mW/chip
(1.8 x nominal)

1 liter/min at 20psi

2 staves in series

Really don't know how to handle/approach this...

Simulations show 42C max at chips with 1.8x the nominal dissipation and no cooling via's through Kapton hybrid yet
Actual temperature will be lower